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Tests on Crushed Stone and Gravel Concrete

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AT the last annual convention of the National Crushed Stone Association a paper was presented by the writer describing the new testing laboratory of the Association in considerable detail and likewise giving the results of some preliminary tests * which had been conducted during the several months of laboratory operation. Necessarily, in view of the length of the paper, all of the tests were not completely described but the results were given largely to indicate to the members of the Association the character of the investigations and the manner in which the laboratory could serve their needs.

Among the investigations were included comparative tests of stone and gravel concretes. It is the purpose of the present article to describe these tests in more complete detail and also to give an interpretation of the results of this preliminary series.

Purpose of the Investigation

The proportions of concrete used for highway construction, almost universally are stated in terms of loose, volumetric measurement of the several materials. There are only a few exceptions to this rule. Thus, it is quite customary for specifications to require that the concrete be composed of one part of cement,— parts of sand, and — parts of coarse aggregate. The proportions which are most widely used are 1:2:3½, meaning one bag of cement weighing 94 pounds, 2 cubic feet of sand and 3½ cubic feet of coarse aggregate measured by volume in a loose condition. Of course there are variations from these proportions and in some instances other means of measurement are employed.

There is no secret in the fact that when crushed stone is used, the volume of concrete produced generally is less than when gravel is employed as the coarse aggregate in concrete of identical proportions. The reason for this fact is that gravel generally has a smaller percentage of voids than crushed stone because it is rounded in shape and rounded particles of a given gradation have a smaller percentage of voids than angular particles of the same gradation. If the gradations differ to any appreciable extent, it may be that, in a few cases, the crushed stone will have a smaller percentage of voids than the gravel but this is not the rule. Since gravel concrete of given proportions occupies a greater volume than stone concrete of the same proportions, it follows that a somewhat lesser amount of cement is used per cubic yard in gravel concrete than in stone concrete. Conversely, stone concrete, as a general rule, requires more cement per cubic yard than gravel concrete when like volumetric proportions are used for both materials.

The question naturally arises as to whether this arbitrary manner of stating concrete proportions for highway construction is really good practice. It undoubtedly survives from the period when concrete was not looked upon as a material which could or should be proportioned in a very scientific manner. The measurement of aggregate, simply by shoveling it loosely into a container of given volume was considered the only practicable method for field use. At first thought, it would seem that when one measures 2 cubic feet of sand and 3½ cubic feet of coarse aggregate, identical quantities of these materials are being employed no matter what may be their gradation, and no matter what may be their shape, provided the measure is struck off level.

It will be interesting to see what are the true facts as to the quantities of materials which may result when volumetric measurement is used and all of the other factors are disregarded. Consider first the fine aggregate. It is now gradually becoming known that the actual volume of solid material in a cubic foot of sand is dependent upon several factors including (a) its gradation, (b) the amount of compaction in the measure, (c) the percentage of moisture in the sand. Sand of rather fine gradation may be swollen in volume as much as 40 per cent by moisture. It would then have 53.6 per cent of voids if it had 35 per cent when

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dry. In a dry condition this sand would have 0.65 cu. ft. of actual solid particles, whereas in a swollen condition it would have only 0.46 cu. ft. of solid material, or roughly there is only 71 per cent as much solid material, or actual sand, in one case as in the other. This variation is quite possible when it is considered that within a given State sands may vary appreciably in gradation and appreciably in moisture content during the working season.

In coarse aggregates the percentage of voids may be as low as 30 and as high as 50 per cent, depending upon the gradation and characteristics of the aggregate used. In one case there is 70 per cent of solid material and in the other only 50 per cent. It is the solid material in the aggregate and not the air-voids with which engineers are really concerned when measuring quantities of aggregates, for it is the solid material in the several aggregates and the solid material in the cement, which, together with the water, make up the total volume of the concrete. It is little wonder that when proportions of materials are stated in terms of loose volumetric measurement, without any consideration whatever of the variation in solid material which may thereby result, that unsatisfactory concrete is frequently obtained, because the actual proportions of solid materials are apt to be different in every case even though the proportions in terms of loose volume are identical. The relative proportions of solid materials plays a most important role in affecting workability and strength and it is high time that engineers recognize this fact. When loose volumetric measurement is used it is frequently the case that the resulting concrete may have, for illustration, 6½ bags of cement per cu. yd. with one kind of aggregate and only 6 bags per cu. yd. when another kind is employed. So that even though the proportions are seemingly identical, the more significant proportions of the concrete, stated in terms of solid volumes of materials or in terms of cement to total aggregate are far from identical.

Crushed stone has borne the brunt of the difficulties resulting from this old-fashioned, entirely illogical, method of arbitrary proportioning of concrete by loose, volumetric measurement, using identical proportions for all aggregates however widely varying they may be and whatever may be the resulting strength and the present series of tests was started in an effort to determine if some other method might not be substituted which would be more logical and which would give more uniformly better results and make for more equitable competition among the various coarse aggregates employed.

Reasons for Selected Basis of Comparison

Concrete highways whether constructed of one coarse aggregate or of another are supposed to be equally capable of carrying identical units of traffic. No further argument need be advanced at this late day to show the extreme importance of cross-bending resistance of concrete for use in concrete roads. Concrete highways primarily are slabs subjected to flexural stresses and when they fail under load, they fail not by lack of resistance to compression but by lack of resistance to either direct tension or to cross-bending. The compressive resistance of concrete in concrete roads is no longer open to any question. The cross-breaking or beam resistance stated in terms of modulus of rupture therefore becomes one of the most important measures of the quality of concrete for road construction. If identical units of traffic are carried and if the thickness of the slab is maintained the same, it is simply good engineering practice to attempt to maintain the beam strength of the concrete at a constant quantity, for otherwise the slabs will not have identical load-carrying capacities.

As the first step in our investigations it was thought necessary to determine how the qualities of concrete compared as they were affected by the various types of coarse aggregate being supplied to the commercial market. In concrete testing it is customary to eliminate as many variables as possible in order to obtain a comparison of the particular properties under consideration. It is common practice to screen the aggregates and recombine them so that they will have identical mechanical analyses, thus eliminating this supposed variable. We gave careful consideration to the question of whether we should prepare our aggregates in this way but we found that the screen analyses of the commercial aggregates submitted from the various parts of the country varied very widely and in many cases the gravel was finer than the stone while the reverse was true in other cases. Commercial gravel being supplied to the market frequently runs finer in size than stone simply because that is the way it occurs in nature; the coarse particles are not obtainable or the finer particles predominate. It seemed entirely illogical to make a comparison of crushed stone with its neighboring gravel, screened to the same mechanical analysis, when actually they were not used in that way. Accordingly, the preliminary tests have been run with the aggregates graded just as they were received and to the best of our knowledge these gradings are the commercial gradings of the respective materials as they

were being supplied at the time of the receipt of the samples.

Any set of comparative tests of materials can be subjected to the criticism that they are not strictly comparative. For instance, if the same arbitrary proportions are used and the concrete is mixed to the same consistency as in our particular case, the criticism might be offered that the concrete did not have the same cement content per cubic yard, nor did it have the same water-cement ratio. If the aggregates were not graded alike, this, too, might be offered as a criticism but the fact is that the mixing of concrete in like arbitrary proportions to the same consistency is the method now most generally used in practice and a comparison on that basis seems to be the best comparison that can be made. Suppose it had been decided to make a comparison on the basis of the same arbitrary proportions with the aggregates graded in an identical manner and mixed to the same consistency; then someone might offer the criticism that actually these gradations are never used with these particular aggregates, and, moreover, the water-ratio was different in each case as well as the cement content. Suppose it had been decided to use the same cement content per cubic yard in all cases, then the proportions would have been different as well as the water-ratio and, perhaps also the gradation, and so a number of bases of comparison might have been used, all of which would be subject to some criticism. The basis of comparison selected for these tests is the basis upon which concretes are judged in actual service today.

Method of Obtaining Samples

Samples of stone were requested from a number of quarries situated throughout the United States. These quarries were selected not with the idea of obtaining the best stone available but rather to obtain stone having as wide a range in physical characteristics as possible. Thus, it was desired that the stone extend from the softest to the very hardest, as determined by the Deval Abrasion Test. The stone producer was also requested to obtain as fair a sample as possible of gravel from a state or county accepted stock pile and we have every reason to believe that a fair sample was shipped to us in all cases. In any event, the essential physical characteristics of the aggregates have been determined.

Characteristics of Coarse Aggregates Used

In table I are shown the various physical characteristics of the coarse aggregates used. The column headed "% Wear" contains the results of the Deval Abrasion Test on stone samples and the Gravel Abrasion Test, as described in bulletin 1216 of the U. S. Department of Agriculture, on gravel samples. It is to be noted that the stone extends in percentage of wear from 2.0 to 7.0 and the gravel from 3.5 to 28.1. It is believed that these respective ranges in percentage of wear include most of the commercial coarse aggregates now being supplied to the market. There is no question that samples Nos. 28 and 31 are far softer than the gravel most commonly used but, none the less, both of these materials are used commercially. In all cases the tests were made in accordance with the standard methods of the American Society for Testing Materials when such standard methods exist. The weight per cubic foot, "loose" was determined in the Standard A. S. T. M. cubic foot measure by merely shoveling the coarse aggregate into the measure and striking off the top. The apparent specific gravity was obtained by the "overflow" apparatus as described in Bulletin 1216 and the percentage of absorption was determined on the same sample as used in determining the apparent specific gravity. When the gravel was heterogeneous in character, an effort was made to select a specific gravity sample which was representative of the material. The percentage of voids was calculated from the weight per cubic foot and the apparent specific gravity by the formula—

$$\text{Percentage of voids} = 100 \left\{ 1 - \frac{\text{Wt. per Cu. Ft.}}{\text{Ap. Sp. Gr. x } 62.4} \right\}$$

Table I. Showing Characteristics of Coarse Aggregates

No.	Materials	% Retained—Square Openings 2″	1½″	1″	½″	#4	% Wear	Apparent Sp. Gr.	Wt./cu.ft. (loose)	% Voids (loose)	% Absorption
2	Stone	....	9	58	83	98	3.5	2.69	91.7	45.3	0.3
3	Gravel	....	2	19	78	99	10.5	2.30	87.3	39.0	2.9
5	Stone	....	3	45	91	99	2.9	2.96	92.3	50.0	0.2
6	Gravel	....	13	41	82	98	16.9	2.63	102.7	37.5	0.7
7	Stone	....	10	39	74	97	7.0	2.58	89.5	44.3	1.3
8	Gravel	....	8	35	78	98	10.7	2.69	103.7	38.2	1.1
9	Stone	8	34	61	85	95	6.7	2.67	95.7	42.5	0.3
12	Gravel	....	....	11	74	99	5.0	2.56	94.6	40.8	0.7
13	Stone	....	13	44	85	98	3.5	2.44	86.2	43.3	2.0
17	Gravel	2	13	51	92	100	8.6	2.55	98.9	37.8	0.6
23	Stone	....	6	33	75	94	2.0	2.62	93.6	42.7	0.1
24	Gravel	1	21	58	91	100	3.5	2.72	103.6	38.8	0.8
27	Stone	....	13	39	71	95	2.8	2.77	97.2	43.8	0.2
28	Gravel	....	3	13	51	93	26.2	2.56	104.9	34.3	0.8
29	Gravel	....	3	36	83	99	3.5	2.56	99.3	37.7	1.0
32	Stone	....	7	50	76	95	2.9	2.61	95.0	41.3	0.3
31	Gravel	....	15	40	71	97	28.1	2.61	103.9	36.2	0.7
35-1	Stone	....	28	57	85	100	3.3	2.76	95.7	44.5	0.3
35-2	Stone	....	28	57	85	100	3.3	2.76	95.7	44.5	0.3

Description of Gravel

The gravel samples had the following characteristics:

Sample No. 3—per cent wear, 10.5. This is a chert gravel composed largely of hard, smooth chert fragments with a few softer fragments of sandstone or shale; sub-angular in shape and somewhat badly weathered.

Sample No. 6—per cent wear, 16.9. This is a heterogeneous mixture of quartz, gneiss, conglomerate, sandstone and igneous rocks. The surfaces are not particularly smooth and many of the fragments appear to be badly weathered and weak, quite angular and a considerable amount of crushed fragments.

Sample No. 8—per cent wear, 10.7. This is essentially a limestone gravel with a small percentage of sandstone and igneous fragments. The surfaces are rounded and somewhat rough; contains a considerable percentage of crushed and angular fragments.

Sample No. 12—per cent wear, 5.0. This is largely a chert gravel with smooth, although slightly pitted surfaces. The fragments are sub-angular in shape.

Sample No. 17—per cent wear, 8.6. This sample shows the same characteristics as sample No. 12.

Sample No. 24—per cent wear, 3.5. This sample is composed of fragments of limestone or dolomite, sandstone and rocks of igneous origin with a small percentage of chert and quartz. There is a considerable quantity of crushed fragments with rough surfaces.

Sample No. 28—per cent wear, 26.2. This is a badly weathered quartz gravel, surfaces rough and pitted, fragments weak, sub-angular in shape.

Sample No. 29—per cent wear, 3.5. This is a heterogeneous gravel composed of fragments of sandstone, shale, quartz, and metamorphosed fragments of igneous origin. Surfaces vary from smooth to very rough; contains crushed fragments. Shape varies from rounded to quite angular.

Fine Aggregate

The fine aggregate used in all cases was Potomac River sand having the following gradation:

Retained on	*Per cent*
4	3.6
10	23.2
14	29.4
28	47.0
48	82.0
100	96.8
Passing 100	3.2

Fineness modulus = 2.82

Weight per cubic foot, dry, loose = 93.7 pounds.

Proportioning of Concrete

Previous to the mixing of the concrete all of the coarse aggregates were separated into various fractions by the use of a vibrating screen and these fractions were sacked and properly labeled. In measuring out the coarse aggregate for each concrete mixture made, these fractions were again recombined in their proper proportions. By using this procedure the difficulty of segregation was eliminated and it was made certain that each batch had coarse aggregate graded as it was received in the laboratory. The materials were weighed so that the proportions would be 1:2:3½ on the basis of dry, loose volume. The sand was weighed in a damp condition but proper allowance was made for the percentage of moisture present. A cubic foot of cement was assumed to weigh 94 pounds.

Method of Mixing

The mixing was done by two men with the use of shovels and enough concrete was made in a single batch to form one beam 6 in. x 6 in. in cross-section and 36 in. long and two, 6 in. x 12 in. cylinders with a slight amount of concrete in excess. The materials were first mixed dry to a uniform color; water was added, the mixing continued; more water was gradually added as the mixing proceeded until judged to be of the right consistency. As nearly as possible, all mixtures were treated in an identical manner. The consistency was checked by the use of the flow table, using fifteen, ½ inch drops of the table. The flow cone was 5 inches high, 10 inches in diameter at the base and 6¾ inches in diameter at the top.

As soon as the consistency was determined the concrete was shoveled into a cubic foot measure, rodded and settled into place and finally struck off carefully. This measure, full of concrete, was then weighed and this weight served as the basis for calculating the cement content per cubic yard of the various mixtures.

Method of Molding Specimens

As our molding equipment consists of 12 steel beam molds and 24 cylinder molds our procedure consisted of making 12 different mixes, involving 12 different aggregates in a single day. One beam and 2 cylinders were made for each aggregate. This process was repeated on 3 different days. In view of the fact that more than 12 aggregates were being compared a mixture was made with a so-called standard coarse aggregate, which in this case is stone No. 35. This mix was

repeated during the second series of tests which involved still another group of aggregates. In this way we were enabled to tell whether any conditions were present during the mixing and curing of the second group, not present in the mixing and curing of the first group. It will be noted that the strength values obtained in the two mixes with stone No. 35, the standard coarse aggregate, for practical purposes were identical, so that it is reasonable to compare all of the aggregates with assurance that all of the conditions were practically alike.

The cylinder molds were filled according to the Standard A. S. T. M. method. The beams were filled about one-third full and were then spaded by means of a slicing tool and the operation repeated with the other thirds and finally the slicing tool was worked around the sides and ends of the cylinder mold to produce smooth surfaces. The final operation of smoothing was performed with a wood float.

As was to be expected, all of the mixtures made were not of equal workability as judged by ease of placing and finishing, even though their flows were made practically alike. To obtain the same consistency, as determined by the flow table, the water-ratios were somewhat different in the various mixtures. However, the range in water-ratio was not very great, extending from 0.80 to 0.88. In some cases the stone required a higher water-ratio than the gravel to obtain equal consistency, while in other cases the reverse was true.

Storage of Specimens

Immediately after molding, the specimens were covered with wet burlap and after settlement had taken place, the cylinders were capped with neat cement paste. The specimens were removed from the molds the day after making and they were then stored for 27 days in a moist room which was maintained within a few degrees of 70°F. and the specimens were kept continuously wet. The curing conditions were almost ideal. The specimens were also protected from drying before testing.

Method of Testing

The tests at 28 days were made on a 300,000 pound Southwark-Emery Universal machine and a metronome was used to control the rate of application of load. The cylinders were loaded at the rate of 250 pounds per second and the beams at the rate of 25 pounds per second. The beams were 6 in. x 6 in. x 36 in. and were broken as simple beams, 20 inch span, with a centrally applied load. Our bearing blocks eliminate eccentricity of loading as well as horizontal restraint at the reaction points. The beams were tested in an inverted position so as to subject the top, troweled surface to tension.

Discussion of Results

It is to be noted that with the arbitrary proportions used there results more cement per cubic yard in the stone concrete than in the gravel concrete, due to the higher percentage of voids in the stone than in the gravel as shown in Table I. The strength results, both in compression and modulus of rupture, are shown in the last two columns of Table II.

Table II. Showing Properties of Concrete, with Different Coarse Aggregates, Graded as Received. Proportions 1:2:3½—Dry, loose, volume. Age—28 Days—Cured in Moist Room. Slump—Approximately 1½".

No.	Coarse Aggregate	Water Ratio	Flow	Wt. Unhardened Concrete, Lbs. per Cu. Ft.	Bags Cement per Cu. Yd.	Compressive Strength	Mod. of Rupture
2	Stone	0.81	163	151.4	6.16	3760	703
3	Gravel	0.88	165	142.4	5.86	3630	558
5	Stone	0.83	165	156.6	6.34	3670	674
6	Gravel	0.84	167	150.6	5.77	3450	535
7	Stone	0.88	161	148.4	6.08	4300	720
8	Gravel	0.85	162	151.4	5.78	3.60	678
9	Stone	0.86	164	149.8	5.94	3600	640
12	Gravel	0.85	167	147.6	5.89	3500	599
13	Stone	0.88	162	147.0	6.13	3800	666
17	Gravel	0.81	164	148.4	5.82	3360	555
23	Stone	0.85	165	149.2	6.01	3810	717
24	Gravel	0.81	165	153.6	5.89	3960	679
27	Stone	0.84	168	152.0	6.00	3680	686
28	Gravel	0.88	168	147.6	5.59	3440	535
29	Gravel	0.83	171	147.4	5.77	3840	622
32	Stone	0.86	161	147.8	5.88	3370	638
31	Gravel	0.86	164	148.0	5.63	3160	517
35-1	Stone	0.80	169	153.8	6.13	3620	701
35-2	Stone	0.81	170	152.6	6.09	3770	712

Those materials which have been grouped are those which occur in proximity to one another and that is the only reason for grouping them in this manner. The results may be seen best in Fig. 1. This figure should not be misunderstood. It may convey the impression that perhaps in all cases stone concrete will necessarily test higher than gravel concrete but a study of this figure shows that this is not true. There are some gravel concretes which test higher than some stone concretes, both in compression and in modulus of rupture and perhaps had certain other samples been supplied to us the gravel concrete might have been higher than the stone concrete. It is necessary to emphasize this point for otherwise the diagram may be misleading. Perhaps the results are better shown in Fig. 2. Here it is seen that the stones in general have a higher modulus of rupture than the gravels and it seems to be the case that those gravels which have the

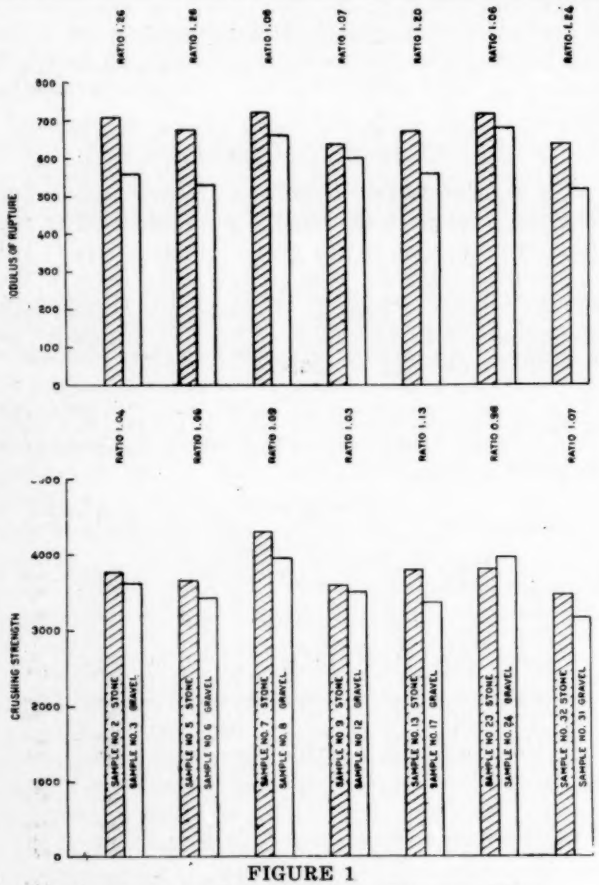

FIGURE 1

COMPARISON OF CRUSHED STONE CONCRETE WITH GRAVEL CONCRETE

1:2:3½ CONCRETE—AGE 28 DAYS—FLOW APPROXIMATELY 165 SLUMP APPROXIMATELY 1½"

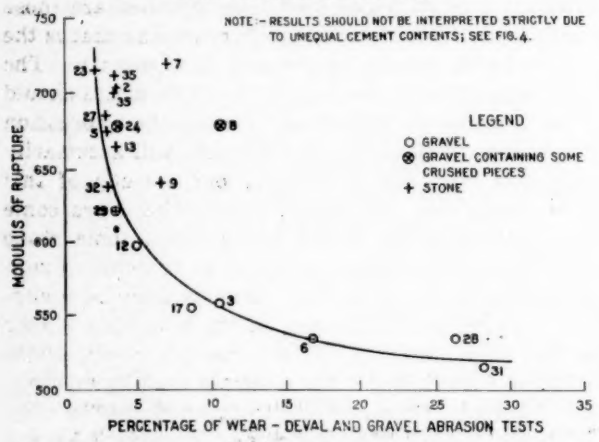

FIGURE 2

EFFECT OF PERCENTAGE OF WEAR ON MODULUS OF RUPTURE

1:2:3½, DRY, LOOSE VOLUMES, 28 DAYS

higher percentages of wear likewise have low resistance to cross-bending, as shown by samples Nos. 6, 28 and 31. It is true that they also run low in compression, although not correspondingly low. It also seems to be the case that the limestone gravel which contains some crushed pieces and also sample No. 24 which contains crushed pieces in addition to limestone fragments give high values for modulus of rupture. It is realized that with the use of arbitrary proportions a low cement content has resulted in some of the gravel concretes which undoubtedly affects the curve showing the relation of percentage of wear to modulus of rupture. Other tests are needed to eliminate the cement as a variable.

Water Ratio Strength Relation

In order to see more clearly the effect of the water-cement ratio on the modulus of rupture of the various concretes, the values for modulus of rupture and water-cement ratio have been plotted in Fig. 3. It

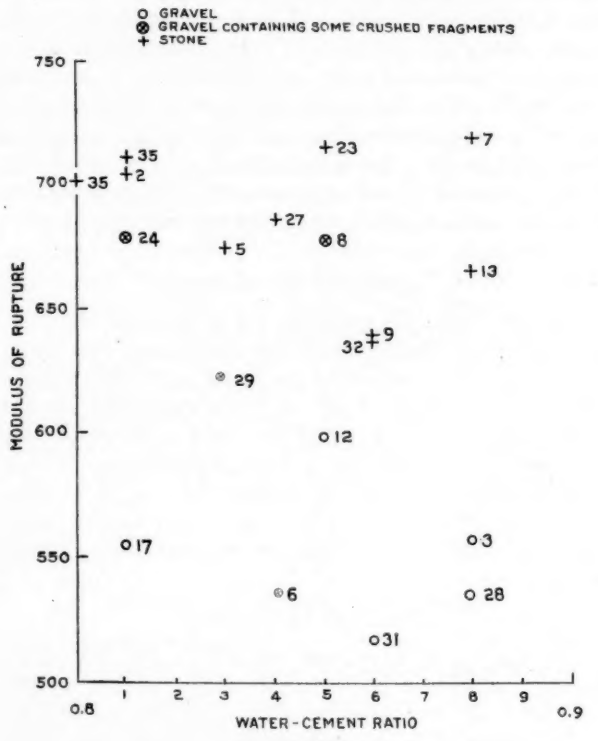

FIGURE 3

EFFECT OF WATER-CEMENT RATIO ON MODULUS OF RUPTURE

1:2:3½, DRY LOOSE VOLUMES, 28 DAYS

is seen at a glance that the water-cement ratio seems to have had no consistent effect on the modulus of rup-

ture. The range of water-ratios used for the gravel concretes was practically as large as that used in the stone concretes and where identical water-ratios were used, the strengths of the stone concretes were all higher than those of the gravel concretes.

Effect of Cement Content Per Cubic Yard on Modulus of Rupture

To study the effect of cement content per cubic yard of concrete on the modulus of rupture these values have been plotted in Fig. 4. Here, there is seen to be

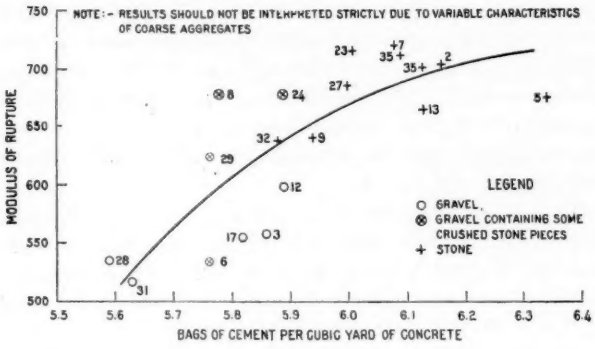

FIGURE 4

EFFECT OF CEMENT CONTENT ON MODULUS OF RUPTURE 1:2:3½, DRY, LOOSE VOLUMES, 28 DAYS

a rather decided trend, for it is noticeable, in a general way, that those concretes having the lowest cement content have the lowest modulus of rupture, and the modulus of rupture tends to increase with increasing cement contents. It is true there are a number of exceptions to this rule and until other tests have been made on the same aggregates in which the cement content per cubic yard has been made identical, no definite conclusions may be drawn.

Judging from Fig. 2 a hasty conclusion might lead one to believe that the percentage of wear of the aggregates has a decided influence on the modulus of rupture but it happens that those aggregates having a low percentage of wear have likewise been so graded that the cement content is also low. Judging from Fig. 4, one might judge that the cement content has a decided effect on the strength of the concrete but, on the other hand, those aggregates giving low results not only have a low cement content but also are very weak as shown by their high percentage of wear.

General Indications

The general indications from these preliminary tests are:

1. That there is a wide variation in modulus of rupture possibly dependent upon the general characteristics of the aggregates including:
   a. Shape and surface characteristics.
   b. Percentage of wear.
   c. Percentage of voids which in turn affects the cement content per cubic yard.
2. There is no relation between water-ratio and modulus of rupture when different aggregates are used.
3. In general, the crushed fragments used in these tests have shown a higher modulus of rupture than the rounded fragments.
4. That the use of identical arbitrary proportions irrespective of the aggregate characteristics results in concretes which may have a wide variation in modulus of rupture.

Investigations to be Undertaken

The tests just described are preliminary and will be followed by other tests to throw light on some of the points still open to question. Apparently, either the lower cement content of the gravel concrete or the characteristics of the gravel, or both, have resulted in a lower modulus of rupture than is obtained with the stone concrete. Accordingly, the next step in the test procedure will be to determine the relation of strengths when the cement contents in all cases are made identical. Should a difference in modulus of rupture still exist, a third step will probably be to attempt to design the respective concretes with the idea of obtaining equal values for modulus of rupture.

Conclusion

The tests so far made surely indicate the necessity for specifying different proportions for concretes composed of unlike materials if like values for modulus of rupture are to be obtained. Perhaps in some cases this may require more cement in the stone concrete than in the gravel concrete while in other cases the reverse may be true. The fact remains, however, that the use of identical proportions results in widely varying values for modulus of rupture and this causes lack of economy, considerable variation in the service value of road slabs and inequitable competition between the several aggregates.

Qualities Required in Paving Concrete[1]

By F. H. Jackson,
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A CONCRETE pavement, from a structural standpoint, consists of a series of flat slabs several feet in width, only a few inches in thickness, and of indefinite length, resting upon a support of more or less uncertain character. It is subjected not only to traffic loads of greatly varying intensity but also to the stresses and weathering effects produced by wide ranges in temperature and moisture conditions. Few concrete structures are subjected to such a variety of destructive forces. In order, therefore, to afford the greatest possible resistance to all such forces the utmost efforts to obtain the best possible product are justified. That so many of the concrete pavements built years ago are still carrying traffic with a reasonable maintenance cost is a tribute to the inherent worth of concrete as a paving material. That so many built within recent years have failed to measure up to the high standard of service required of them should serve as a warning that the best engineering control of design and construction is necessary if satisfactory results are to be obtained.

Destructive Agencies Continually at Work

The destructive forces that are continually at work upon concrete pavements may be divided into two general classes—those due to natural causes, such as variation in temperature, moisture, etc., and those due to traffic loads.

The natural forces produce direct tensile and compressive stresses and a number of complex stresses or "weathering effects," which sometimes cause partial or complete disintegration. It is to resist these latter disintegrating forces that we strive to produce what we term durable concrete. The direct stresses that result from natural causes are commonly produced by the resistance offered by the subgrade to the free expansion or contraction of the concrete slab. They may be induced either by changes in temperature or moisture content, or both. They are present practically from the moment the pavement is laid and they continue throughout its existence.

To combat these natural forces concrete should possess high resistance to both compression and tension. Resistance to compression has, at all times, been considered an important property and for many types of structures it has been deemed the most, if not the only, essential property. However, in the case of pavements, tensile strength is fully as important and perhaps of greater importance. For it is by tensile stress that transverse cracks are formed early in the life of the pavement; and in spite of many opinions to the contrary, a crack in a concrete pavement must be considered as a structural defect. This is particularly true of unreinforced pavements in which an open crack is, in effect, an unsupported edge and, as such, for a given thickness of concrete, becomes the weakest part of the structure.

It has been shown [2] that a direct relation exists between the tensile strength of the concrete and the amount of transverse cracking which will take place in a pavement slab. Other things being equal, the spacing of the transverse contraction cracks will be directly proportional to the tensile strength of the concrete at the time contraction begins.

Much could be written regarding the necessity for continued and adequate curing of concrete in order that its tensile strength may be built up before the pavement is allowed to dry out and tensile stresses are induced which will tend to crack it. The discussion here will be limited to pointing out that thorough curing, especially during the period immediately following the casting of the slab, should tend to reduce the number of contraction cracks, especially those surface cracks or checks induced by the drying out of the surface of the concrete at a greater rate than the mass.

Frequent repetition of stress, whether caused by natural forces or traffic loads, is known to produce fatigue effects; and it is also known that under sustained load or force, concrete is capable of a certain flow by which the stress is relieved. These phenomena are as yet not well understood and require much further investigation.

As the result of research work by the Portland Cement Association and other organizations, the water-cement ratio law governing the strength of concrete has been established. The writer believes that this principle, when correctly applied, affords the simplest

[1] Paper presented under the title Special Characteristics of Concrete for Pavements at annual meeting of American Concrete Institute, Detroit, Mich., February 12 to 14.
Reprinted from February, 1929, issue of *Public Roads*.

[2] A. T. Goldbeck, Public Roads, August, 1925, The Interrelation of Longitudinal Steel and Transverse Cracks in Concrete Roads.

and most practical method yet devised for designing concrete mixtures for a given strength. But, simply because the average of many thousands of tests shows that a certain crushing strength may be obtained with a given water-cement ratio, it may not be assumed that the water-cement-ratio theory is an adequate basis of design for paving concrete.

As previously stated, crushing strength is not the most important property of paving concrete. Tensile strength and flexural strength are more important; and we are not at all sure that the water-cement ratio is the most important factor in controlling these properties.

Experiments by the Bureau of Public Roads [3] and other organizations have shown that the strength of concrete in tension is affected to a much greater degree than the compressive strength, by the character of the aggregates employed. However, these experiments indicate that for a given combination of aggregates and cement, the water-cement ratio governs the tensile and flexural strength as closely as it governs the compressive strength. The best solution is believed to be the so-called trial method of proportioning which was described in a recent issue of PUBLIC ROADS. [4]

Sound Aggregate Required to Prevent Weathering

The slowly acting but continued destructive effects of weathering and frost action on concrete pavements, though admittedly of great importance, are still but slightly understood. We speak somewhat vaguely of "durability" as essential in all classes of concrete exposed to the weather or to corrosive action of any sort, but we are not nearly so certain as yet of the factors which affect durability as we are of those which affect strength. The question arises: Is strength a measure of durability, and if not what factors affect durability which do not affect strength? In an effort to throw light on this subject, alternate freezing and thawing tests of concrete are being conducted in a number of laboratories. These tests indicate that unsound aggregates invariably produce unsound concrete; but there are certain types of unsound aggregates which appear to produce concrete of satisfactory strength though still unsound.

In general, however, the factors which affect durability also appear to affect strength. This applies particularly to the amount of mixing water used; and it may be definitely stated that, given sound aggregates, the best insurance against frost action and weathering effects appears in general to be the use of as low a water-cement ratio as is consistent with the requirements of workability.

Such materials as shale and certain varieties of flint occurring either in the fine or coarse aggregate, must be avoided if sound concrete is to be obtained. It is surprising, however, what a wide variety of aggregate types may be used to produce durable, sound concrete, provided the latter is properly designed and fabricated. It seems safe to say that any aggregate which will pass the sodium sulphate soundness test [5] will contribute to satisfactory durability in concrete which is otherwise of good quality. Conversely, failure in this test should subject the aggregate to suspicion until a thorough field investigation at the source has convinced the engineer that it is a safe material to use. Control of aggregates, however, will go for naught unless proper care is exercised in fabrication, and it is the failure of the field man to recognize one or more of the fundamental principles of good concrete construction that accounts, in the author's opinion, for most of the failures which we are apt to attribute to lack of durability.

Scaling Largely Due to Porous Mortar on Surface

Surface scaling is not well understood, although there is considerable evidence to indicate that it is almost entirely the result of frost action. That scaling is not observed in the South, but is confined entirely to the Northern States substantiates this view. It has been possible to simulate the surface scaling of concrete as observed in service by subjecting laboratory specimens to alternate freezing and thawing. Surface disintegration almost always begins on the top of the specimen, and is probably due to the inability of the relatively weak, porous mortar surface to resist disintegration to the same extent as the mass of the concrete.

If this view of the case is correct, it indicates that effort should be made to prevent the formation of such a porous mortar top on the surface of the pavement to minimize the danger of scaling. The use of a stiff concrete just sufficiently plastic, to settle into place without tamping; the use of a fine aggregate containing as little silt or other fine material as possible; and the removal of the thin surface with lutes just prior to final

[3] Comparative Tests of Crushed Stone and Gravel Concrete in New Jersey, F. H. Jackson, U. S. Bureau of Public Roads, PUBLIC ROADS, February, 1928.

[4] The Design of Pavement Concrete by the Water Cement Ratio Method, reported by F. H. Jackson, Bureau of Public Roads, PUBLIC ROADS, August, 1928.

[5] U. S. Dept. Agr. Bul. 1216, rev. p. 20.

finishing; these measures should go far toward preventing this type of destructive action.

Surface scaling followed by disintegration may sometimes be due to the use of unsound aggregates, but it appears that failures from this cause are more or less local and do not compare in extent to the scaling which may be attributed to the presence of a porous mortar top.

Effects of Traffic Loads Considered

The major stresses in concrete pavement are undoubtedly the bending stresses produced by traffic loads, applied either statically or with impact. In general, these stresses are a maximum along the edges and at the corners of the slabs. Much work has been done in establishing the most economic pavement cross section for uniform slab strength. It is not the purpose of this paper to discuss slab design, but it may be well to point out that the adequacy of the design depends entirely upon how closely the strength of the concrete as actually placed conforms to the strength assumed in the design. In all formulas for pavement slab design a unit flexural strength of about 300 pounds per square inch is ordinarily assumed, and the thickness of slab necessary to carry a given maximum wheel load is calculated on this basis. For a factor of safety of two, this requires the design of a concrete mixture having a modulus of rupture at 28 days of 600 pounds per square inch, which is equivalent to a crushing strength of about 3,000 pounds per square inch.

It has been stated that the water-cement ratio principle may be used to design concrete of a given flexural strength, provided it is recognized at the outset that such factors as angularity and surface texture of aggregates affect the flexural strength to a greater extent than they affect the compressive strength. Tests are now being made by the Bureau of Public Roads, in which 17 typical varieties of coarse aggregates including trap, limestone, granite, calcareous and siliceous gravels and blast furnace slags are being investigated. They show that for a given mix, grading, and water-cement ratio, the maximum variation from the average flexural strength of concrete made with these aggregates is 25 per cent. An illustration from one of the four mixes employed in the investigation may be cited.

The flexural strength (modulus of rupture) of a field, volumetric 1:2:3 mix, using a fixed consistency and with the water-cement ratio falling within a total range of 0.05, varied from 530 pounds per square inch to 650 pounds per square inch at 28 days, due entirely to the kind of coarse aggregate employed. This difference in strength is equivalent to that which would result from a change in the water-cement ratio of 0.15, a variation which should certainly not be ignored in applying the water-cement ratio law. The change in flexural strength was not accompanied by any significant difference in crushing strength, indicating that even quite wide variation in the character of the coarse aggregate had no appreciable effect upon compressive strength for a given water-cement ratio. This point is emphasized to show that in designing pavement concrete mixtures, other factors besides water content must be considered.

Surface Wear Not a Critical Factor

Many engineers believe that high resistance to wear is no longer important and point to pavements carrying heavy traffic which were constructed with relatively soft aggregates and which still show the original finishing marks. On the other hand, the use of steel, non-skid chains in winter does produce wear. This is about the only destructive agency of this type left, since the steel wagon tire has practically disappeared from our highways, except in certain restricted regions. On the whole, the writer is inclined to believe that surface wear is not a critical factor and that, in general, a concrete mixture which has been properly designed as to strength and durability will also be satisfactory from the standpoint of surface wear.

Quality of Pavement Concrete Affected by Construction Methods

Attention has been called to the fact that the quality of concrete depends fully as much upon the care used in construction as upon the materials employed or the proportions established in the design. Satisfactory construction can not be secured by the type of engineering control which very carefully specifies the quality and grading of aggregates to be employed, sets a mix which under laboratory conditions will give the desired strength, and then employs an incompetent inspector on the job. Such inspection is unfair to the contractor, as well as to the public, because it often leads to arbitrary and unreasonable interpretation of specifications and results in unnecessary delays and increased cost.

It is believed that there are cases where quality in construction is sacrificed in order to increase the production. Maximum efficiency is, of course, much to be desired in all construction operations, and studies by the bureau have shown that there are many instances where production can be increased without sacrifice of quality. It must be remembered, however, that mere speed should not be permitted to become the controlling

factor beyond the point where it is possible to maintain the highest standards of workmanship. Furthermore, no established practice as regards construction should be modified for the purpose of increasing production without first determining very definitely that the proposed modification does not adversely affect the quality of the finished product.

We should also be alive to the possibilities of improving the quality of our concrete, especially if we can do so without increasing cost of production. With this thought in mind, the Bureau of Public Roads is now actively promoting certain principles in connection with production of concrete for pavements which will, we believe, result not only in more uniform quality but will also tend to reduce the ultimate cost to the public. These principles are as follows:

1. The abandonment of volumetric proportioning of aggregates and the adoption of proportioning by weight. Inundation will be recognized as a permissible alternate method for fine aggregate, but weighing will be preferred.

2. Maintenance of the lowest water-cement ratio which, with the type, grading, and proportions of aggregate and methods of finishing employed, will produce a workable, dense, and uniform concrete.

3. The scientific grading of coarse aggregate by combination of separated sizes in each batch in the proportions which will produce the maximum practical density.

4. The abandonment of hand-finishing methods.

The State specifications previously approved by the bureau for Federal-aid concrete pavements provide for certain standard proportions of cement and fine and coarse aggregate. As a result of recent tests the bureau is now convinced that better and more economical concrete may be produced in some instances by increasing the proportion of coarse aggregate previously specified, providing the density and uniformity of the mix are not impaired. It has, therefore, announced that where adequate engineering control is assured, the coarse aggregate proportions previously approved may be increased if, by combination of separated sizes in each batch, a well-graded aggregate is produced and the resulting concrete is dense and uniform, workable by the methods of finishing employed, and of a quality at least equal to that produced by the approved standard mix.

The bureau feels that improvement in uniformity as well as increased economy will be accomplished by measuring coarse aggregates in two or more separate sizes. This practice will insure the maintenance of a uniformly low void content in the coarse aggregate and make it possible to reduce the amount of mortar below that necessary under the present practice where quite wide variations in voids occur frequently from batch to batch, due to inefficient mixing of sizes at the producing plant or stock pile segregation. The practicability of this procedure has been demonstrated in actual construction in North Carolina, where a mix containing considerably more coarse aggregate than we have been in the habit of permitting has been used by combining three separate sizes of coarse aggregate.

Another outstanding advantage of handling and proportioning coarse aggregate in this manner is that it makes possible much closer control of water at the mixer, through the elimination of a variable, which has caused more trouble than is commonly supposed. This is the fluctuation in the water requirements of individual batches due to changes in grading. Batch-to-batch variations in the quantity of the finer sizes of the coarse aggregate—that is, the material ranging from about three-fourths inch down—are quite common under the present practice and cause marked variation in the workability of the concrete. This leads to a tendency on the part of the mixer operator to control the workability by changing the amount of water. It will be admitted that uniform water content is essential to uniform concrete. Measurement of coarse aggregate in separate sizes will contribute much to this end.

With regard to hand finishing, the bureau feels that smoother riding surfaces can be produced with mechanical equipment, and also that it is possible by mechanical means to handle economically and efficiently a drier concrete and one containing a higher percentage of coarse aggregate than when hand-finishing methods are employed. The manner in which a finishing machine will handle a concrete which by all laboratory standards would be labeled unworkable has considerably altered our conception of what we term (for want of a better name) "workability" in concrete.

The bureau believes that the loose methods of control which have been the rule in the past have often led to the use of proportions capable of producing a concrete of considerably higher strength than that called for in the design, in order that we might be certain of obtaining the design strength in the field. We have been employing a factor of safety in the shape of richer mixtures to take care of inadequate control methods. The greater certainty of the methods proposed should enable us to design and produce concrete conforming more closely to whatever design requirements may be imposed with resulting benefits both physical and economical.

What Every Safety Engineer Should Know*

By David Van Schaack,
Director, Bureau of Inspection and Accident Prevention, Aetna Life Insurance Company

IT seems to me that the first duty of the safety man is so fully to convince his employer, if he is not already convinced, of the value of and the necessity for accident prevention that the money, as well as the organization, requisite for adequate safeguarding will be promptly forthcoming as needed. An appeal to the employer's sense of social justice, or to his humanitarian feelings, often goes a long way, much further now than heretofore, but there can always be most advantageously coupled with this, if not made the primary argument, an urging of the value of accident prevention in dollars and cents.

The employer who does not see that accident prevention is his duty cannot fail, if the facts are properly presented, to appreciate that it is an economic necessity. As a prominent safety engineer has well said: "The employer who ignores the personal element in his business today is doomed to failure, and as business competition continues to increase, the more is this true."

The several ways in which industrial accidents are wasteful are too well known to call for enumeration. The cost of accidents in money, in lost time, in interruption of business activity, in consequent spoiling of material and product, in uncompensated overhead, in labor turnover, has been pointed out so frequently and forcibly for years that it needs no repetition here. The strenuous business competition of today calls for the highest degree of efficiency if success is to be attained, and industrial accidents are such an actual and potential cause of impairment of efficiency that they cannot be ignored.

Once the opportunity to do adequate safeguarding is obtained, and the means of accomplishing it are at hand, the actual provision of safeguards must be approached in a truly scientific manner if real results are to follow their installation. Only a careful study of working conditions, a painstaking analysis of accidents occurring under them, and a searching inquiry into potential causes of accidents that may not have occurred will determine truly the hazards to which workmen are exposed and indicate the correct means of overcoming them. No remedy can be effective which is based upon a wrong diagnosis.

Conversely, the best of diagnosis will be futile unless it is followed by the furnishing of the right kind of remedy. The nature of the safeguard to be provided is of just as much importance as the determination of the risk. A safeguard has two functions, that of effect and that of appeal. To fulfill these functions, it must not only be necessary, and calculated really to prevent the accident which it is designed to avert, but it must serve its purpose without unnecessary interference with the doing of work. In a word, it must be practical, wholly practical, and nothing but practical.

David Van Schaack

If a safeguard is impractical, whether in effect or in appeal, it is useless and a hindrance rather than a help to the cause of accident prevention. You can not expect an employer to continue spending his money for unnecessary safeguards, for safeguards which do not guard, or for those which do guard at the expense of a too material loss in efficiency. You cannot expect a workman to use a safeguard, if use can possibly be avoided, when its predominant appeal to him is that of an unnecessary interference with his work.

*From February, 1929, issue of *Safety Engineering*.

Of course, the best time to provide for mechanical guards, and many other safety conditions, is when the machines are building or the plant is being planned, but unfortunately much safeguarding is still an afterthought. This can be avoided to a large extent by the careful checking of plans and specifications for new machinery and equipment, and, too, in perhaps a more limited degree, for new construction, and for alterations, repairs and rearrangements in order to see that every safety requirement is covered so far as possible. As for the rest, the best must be done with the opportunity at hand.

The standardization of safeguarding is progressing steadily, but there is much yet to be done, and the safety engineer will do well to adopt every possible means of keeping in touch with the experience of others, both generally and in his own line of work.

There is no better way of assuring that a safeguard will be thoroughly practical, will fulfill both of its functions, that of effect and that of appeal, than to enlist the aid of the man on the job, the foreman and the workman. No one else knows so well the true risks of the work involved, the ways in which these risks lead to accident, and the manner in which they can be avoided with the least interference with work. And there is a psychological result of such cooperation, the value of which cannot well be overestimated. If the man on the job feels that he has actually had a real part, even though a small one, in the provision of a safeguard for work which he is doing, or which is being done under his supervision, he is pretty sure to use it or to see that it is used. He comes to look upon it as his guard, and naturally to take the keenest interest in its maintenance and use.

It is cooperation, indeed, which is the basis of all really effective safety work, of safeguarding as well as of organization and education. Without cooperation little worth while, nothing either far-reaching or permanent can be accomplished. If you are to achieve anything like the full measure of results, you must get the men interested as well as the bosses, and you must everlastingly keep them interested, both men and bosses. You must be an advertiser, not blatantly but persistently. The familiar saying, "It pays to advertise," applies nowhere better than in safety work.

One of the pioneers in safety work struck the keynote when he said that the best safety device was a safe man. Another has put it that the greatest factor operating toward the prevention of accidents is not the prevention device, but the "prevention spirit." The safety slogan which has the strongest appeal to me is "get the safety habit." There is a lot of meaning in that phrase. Safety habit is but another way of spelling caution, which is the one and only preventative of so large a number of industrial accidents. The safety habit may, perhaps, not be so easy to acquire as some other habits of which we know, but it is certainly much more worth while.

I do not think I exaggerate in making the statement that promoting the safety habit, getting the men to think safety and to think it unconsciously, is the biggest thing you safety men have to do, and the most difficult. It is the leading feature of the general educational work which is the keynote of all successful accident prevention campaigns. Workmen do not intentionally get hurt, but ignorance and thoughtlessness are the most prolific causes of accidents, and these causes can be eliminated only through a comprehensive plan of education.

It has often been said that recklessness and carelessness are among our national characteristics. I prefer to believe that it is the American workman's fine sense of independence that leads him instinctively to pass his own judgment upon matters affecting his safety as well as all other matters. He must, therefore, be educated so that his judgment will be correct. He must be made to see that risks actually do exist, that he as well as others is subject to them, and that he must habitually exercise caution if he is to avoid their consequences.

He must be brought into such a state of mind that when the time comes for taking the dangerous chance he will instinctively visualize the accident which may result if he takes it. His imagination must be developed and pointed in the right direction. It is curious how many workmen seem unable to picture themselves in the place of a man injured. It is curious, too, how many will appreciate one danger and fail to see another, even one correlated. There are workmen who will be scrupulous to use only tools in good condition, but will fail to wear goggles when grinding those very tools.

That blind confidence in the record of the past, so generally present, must be overcome—that feeling that because nothing has happened while the work was done in the good old way, nothing ever will happen. So, too, must the frequently held belief that the introduction of guards and safety practices is a reflection upon the workman's ability to take care of himself. Workmen are just like the rest of us. Through long usage, they fall into confirmed habits and are resentful of innovations.

I do not wish to appear as belittling the value of discipline, of creating and then enforcing rules. I think, however, that great care should be taken in the framing of rules and that they should be as few as possible, and I believe that discipline should always be a last resort. Of course, every rule that is made should be rigidly enforced when necessary. Otherwise no rule will command respect. A great aid in securing obedience to a rule is, before promulgating it, to get some leading men in the work affected, if possible a majority of all the men, to follow the desired practice. Their example, procured by a combination of suggestion, education and persuasion, will obviate much of the need for coercive measures. Especially should the foreman be in full sympathy. Not only is his the closest authority, but he is the natural teacher of the men and the example whom they emulate. The foreman often makes the best rule book and danger signal.

The ways of educating workmen into the safety habit are almost innumerable. Practically every step you take in your safety work has its part in this education and you will do well always to keep this fact clearly in mind. The provision of safe working places and safe tools is a feature of education, as well as a direct means of preventing accidents. So, too, and most notably, is about every other phase of safety organization, for the promotion of fellowship, through bringing the men, and the men and the bosses together, is a very vital factor in safety work.

Safety engineering is really human engineering, and the only way to get anything like the full measure of results is to obtain the sympathetic cooperation of every man in the plant who can be reached.

You cannot get the cooperation of workmen by preaching to them, but you can get it by a sympathetic method of arousing their interest. In a way they must be approached as entirely ignorant of a new subject. As I have said before, they must be shown, and one of the best ways of showing them is to let the facts, of risks, of accidents, and of other shops' experience, speak for themselves, through photographs, slides, exhibits, etc. A well-conducted bulletin board, for instance, is one of your most potent aids.

Everything tending to keep safety uppermost in the minds of the men, such as the showing of safety slogans in one way or another, if of great value. So, too, is any means of stirring up the emulation of the foremen and men. There is nothing like getting the spirit of emulation into safety work. If you can get the foremen and workmen of a department interested in beating their own safety record, or in competing with the safety records of other departments, it will be a tremendous help.

Perhaps the one man in whom you should be supremely interested is the foreman. If you can interest him, if you can help him to see clearly the causes and remedies of accidents, if you can make him feel that accident prevention is worthwhile, I venture to say that a considerable part of your entire work is accomplished. The foreman is potentially your most valuable assistant. If he will only give the matter his serious attention, he is in the best position to note the real hazards of the work and to determine the true causes of accidents. It is he, too, who can best avoid the accidents so often due to men not being carefully instructed how to do their work or not being suited to it. He is also closer to the men than anyone else in the plant can possibly be, and his influence in inducing them to acquire the safety habit can be enormous.

You yourself are, of course, familiar with every nook and corner of your plant. You are continually inspecting for hazards. If you have got close to the foreman, if you have been able really to make him your friend, an off-hand suggestion to him as to how he can improve his department from the safety standpoint will have the best effect. The more of this verbal correction that you can do the better. As I have already said, safety engineering is human engineering in its greater part. It is the habits of men that you have to change, and to accomplish this there is nothing like the close personal touch. You should not fail to try to make every foreman your friend, and so far as possible every workman.

There is just one more feature of accident prevention, and a very important one, to which I should like to call your attention. This concerns itself with the selection of men for work and their instruction in it. Too little attention, from the safety standpoint, is often given to these matters. To put a heavy, slow-thinking man on a job requiring both bodily agility and mental alertness, or vice versa, is simply inviting accident. So, too, is assigning a man to work without carefully instructing him how to perform his duties safely as well as otherwise efficiently. Every new man on a job should be carefully instructed in general safety as well as in the safe way of doing his particular work. Especial pains should be taken with the recent immigrant and with all non-English speaking men. This cannot be emphasized too strongly. It is a most important feature of a comprehensive safety campaign.

The Business Man and His Trade Association*

By Hugh P. Baker, *Manager*
Trade Association Department, Chamber of Commerce of the United States

The Road Ahead

YOU are exercising an inalienable right as business men and as American citizens in coming together here to discuss the problems with which you are confronted in your business; to discuss ways and means of developing your business on a more satisfactory basis and on a basis that will bring a sounder profit.

The National Chamber feels that because of certain Supreme Court decisions of a few years ago and accumulating trade association experience of a successful nature, the road ahead for trade associations is much clearer today than ever before. As a well organized and efficiently managed trade association you are in a position to travel that road in such a way that it will make for better business and sounder profits, and that, whether your business is large or small and whether you are located in a metropolis or at the cross roads, providing of course that you act as a good sportsman in business and observe the rules of the roads.

The National Chamber and American Business

It gives me pleasure to bring greetings from the National Chamber of Commerce, a national federated organization made up of some 1,500 local Chambers of Commerce and national and state trade associations.

Just a brief word as to the Chamber and its place in American business. Your Association, in accomplishing the program which you have set up, is not your President, your Vice President or the other members of your staff, or the Association offices, but rather it is you men who are investing in Association work with the idea that you are to get sound returns from it. You are the Association.

And so it is with the National Chamber. Your organization, as a member of the Chamber, and the other trade associations and chambers of commerce throughout the country making up the National Chamber are the Chamber. You determine our program and our policies. And we are doing our utmost, in that fine building down in Washington made available for us through the generosity of American business men, to carry out the principles and the program which you have laid down for us. And I come to you, therefore, representing your organization in a sense, to report to you upon the work which you have indicated that we should carry on in the building up of sounder trade associations; associations that will serve business in a more effective way in the solving of the difficult problems with which business is confronted.

Trade Association Not a New Business Effort

You are operating your association with a definite program and according to certain principles. The principles which you have developed as being those which should guide you in your work are not new principles in organized effort. There were trade associations operating under the same principles which apply in your work almost as soon as business began. And who is to say when business began among men?

We know that in the Roman Empire there were organizations in trade very similar to the trade associations now active in this country. The individual trade association at that time was known as a Collegium, and when the Romans went over into Great Britain, they took their collegia or trade associations with them. From these earlier organizations were developed the Guilds of Medevial Europe. There were merchants' guilds, craft guilds and other forms of guilds. And doubtless from the guild idea, the trade association has developed in this country carrying on the very old conviction among men that progress and profit will result in business through organized effort.

You remember one of Aesop's stories which illustrates very well indeed what business men are seeking to accomplish through organized effort. This story of Aesop's tells of the dying father, who called his seven sons together, asking that each should bring with him as he came to his bedside a stick of a certain length. And the dying father took these seven sticks and bound them together and showed the seven sons how difficult it was to break the bundle when it was bound together. Then he separated the bundle and showed the seven sons how easy it was to break each individual stick.

And so with us in the work which we are doing in our trade associations; we must make the word "co-operation" effective in binding ourselves together so

*Presented before the Twelfth Annual Convention of the National Crushed Stone Association, Cleveland, January 21, 1929.

strongly that we cannot be broken apart in accomplishing these things which we know industry needs to bring about better business, and business with a sounder profit.

Trade associations have been functioning successfully for many years in this country. For eight years it was my pleasure to manage the association representing the pulp and paper industry of the United States. That organization celebrated its fiftieth anniversary two years ago. We were fifty years old and in continuous existence all that time, and we had accomplished some very worthwhile results. Reference will be made to that association from time to time to indicate what the effect of organized effort has been upon an industry when that industry learns to know its association.

The Trade Association Has Come to Stay

We know that the trade association has come to stay in American business. Conditions are such in industry today, that if for any reason the Association serving the industry were wiped off the map tomorrow, in six months doubtless the industry would have to come together again for unified action in meeting its common problems.

That the association has come to stay in American business is evidenced in several ways. First and of prime importance, by the newer attitude of the bankers of this country toward trade associations. Bankers are apparently deciding the credit to be extended in financing business activities more and more by a man's ability to come together with his competitors in a trade association; to stand shoulder to shoulder with him in unified action that will bring better business; business that will build the industry soundly for the future. The fact that the American banker is recognizing the trade association, in my opinion, is important evidence that the Association has come to stay.

Another evidence is the fact that there is no industry of importance in this country that does not now have a trade association.

Still another evidence that the trade association has come to stay is the fact that there is an active and growing national organization of trade association executives. Recently this organization met at Montauk Point, New York. At this meeting more than 150 managers and secretaries of trade associations came together in a three-day session to discuss the problems with which we are confronted as trade association executives; to discuss ways and means of building sounder trade associations that there may be better service given by trade associations to the industries which they are organized to serve. At this meeting there was also full discussion of some of the economic problems with which business is confronted. The trade association executive, unless he can understand fully the business problems with which his group are confronted and have some vision in those problems, cannot be really effective as the manager of a trade association.

The trade association has become not only a business man's organization but a business organization. The more we study trade association work, the more we meet with business men in their offices and at conventions and learn to know you and the constructive work you are doing through your association, the more apparent it becomes that the trade association is becoming an industry-wide corporation.

In the paying of dues into this organization and similar associations throughout the country, business men are investing in industry-wide corporations and it is becoming clearer almost from day to day that these investments in association work can be made to give definite returns in services of a dollars and cents value.

If you and those like you in the more than a thousand other trade associations in the country would take the same interest in getting a return on the investment which you are making in your association, that you are taking in getting a return on the investment which you are making in stocks and bonds, there would be little question as to the effectiveness of the work of our trade associations.

There is yet another evidence of the fact that the trade association has come to stay, and that is that the National Chamber of Commerce has recognized the place of the trade association in business and has organized a Trade Association Department to assist business in building sounder trade associations. And the Chamber, in the development of this new department, is trying to help industry everywhere in this country in building the kind of association that will produce effective cooperation in business and bring us what we are all after, and that is better business and sounder profits.

Mergers and Combinations and the Trade Association

It might be well to take just a minute to discuss the development of trade associations as a whole in this country and what the trade association movement may mean to business. You men are thinking business men.

You are exercising vision as to the future of your own business. What vision have you as to the future of business as a whole in this country? It would seem necessary for us at times to take a look forward because we have some very difficult problems confronting us as business men as a whole in this country.

Where are we going in American business with these mergers and combinations that are taking place? How far can we go with these mergers without bringing down upon us as business men the same criticism by the public that brought about the period of "trust busting" and restrictive legislation of the 90's?

Are we headed into a period where we will be faced with further "trust busting" and further restrictive legislation?

It is time as business men that we give some thought to these things. It would appear that trade associations as they are now developing, and if properly guarded in their growth, can be made a constructive force for the maintenance of industrial democracy. Working together in a legal and harmonious way, the trade associations of the country should be able to guide this development of mergers and combinations in business in such a way that the criticism of the public for further restrictive legislation may be avoided. And you can coordinate the work of your organization with other national organizations, not only in the industry in which you are interested as a whole but with business generally, to the end that American business should speak for itself soundly and effectively in what it has to accomplish in bringing about better business and sounder profits.

What is a Trade Association?

For the purpose of focusing thought and limiting discussion it might be helpful to give a short definition of a trade association. What is your organization? Where are you headed? What are you getting out of your organization? And are you sure of the future of your organization and its effect upon your business?

In answering the question as to "What is your organization?" it might be helpful to give a definition of a trade association in short form which we are suggesting as meeting the need of a clear definition. This is: "A trade association is an organization of business men in and serving an industry or a trade for mutually helpful service and for better business." The phrase "and for better business," has been added to the definition of a trade association because it is very certain that you wouldn't be coming together here in these conventions, with all of the expense involved, unless there were very clearly in your mind the fact that you are investing in service from an organization that will bring you better business. And that is what our trade associations are in existence for today, to bring us better business and profit on a sounder basis.

Values Accruing from Association Work

It should be of interest to bring up other questions which, if effectively answered, should help to emphasize the value of association work. You might well ask yourselves: "What values are accruing to my industry from the work of the association?"

Reference was made to my having managed the American Paper & Pulp Association for eight years and the fact that two years ago we celebrated our fiftieth anniversary. It seemed to some of the leaders in the paper industry that it would be very interesting and perhaps helpful if we could determine reasonably well the effect upon the paper industry of fifty years of organized effort.

It should be of interest and of value to you, at the end of five years or ten years to analyze the effect upon your industry of five or ten years of organized work through your association. After all, what values have accrued to your industry through these years of association work?

After it was decided that it would be helpful to the paper industry to determine the values that have accrued to the industry from fifty years of association work, we went back through the minutes of annual meetings of the American Paper and Pulp Association for fifty years, back to the first call for a meeting sent out in 1878 by a group of paper manufacturers in and about Springfield, Massachusetts.

You would be interested in that first call, because it is a statement that sounds very much like a program for an association meeting of today. That first call indicated that there was overproduction in the paper industry in 1877, that there was price-cutting, that there was invasion of sales territory, that there was serious foreign competition, and that there were practices that were both harmful and wasteful. Therefore, it was suggested that it would be a good thing for the paper manufacturers to get together to discuss conditions and to see if helpful results would not accrue from organization.

And that first call, as indicated, sounds like the program for a meeting of such an organization as yours or any other trade association in industry today, be-

cause the problems with which you are confronted today are very much the same that confronted the paper industry in 1877 and these are, overproduction, price-cutting, invasion of sales territory, wasteful and harmful practices making for unfair competition.

In going back through the minutes of the fifty annual meetings of that organization, the evidence as to the value of organized effort in the paper industry was very different from what we had expected. We had assumed that fifty years of association work would indicate certain definite and tangible results; that because the association had developed certain statistical reports, had made some progress toward uniform cost methods, trade extension, and so forth, that some very definite and tangible results had been achieved for the industry. But the evidence proved that the greatest values that had accrued to the paper industry from fifty years of organized work were what might be called the intangibles of association work—better acquaintanceship, good fellowship and confidence.

And if you will stop to think, you will appreciate quickly that the things you are seeking to accomplish in your organization, the constructive activities outlined in your program, cannot be accomplished satisfactorily unless there is reasonable confidence as between the members of your association, confidence in each other and in the association and its management.

And just in proportion to the way in which you can develop confidence in each other, you should get results, tangible results, that you have a right to expect from your organization; results that will indicate to you that you are getting a return on the investment which you are making in your association.

Much progress is being made through association work in placing business on a better plane. This effort and the values accruing from it are among the most worthwhile results from effective association work. Men are coming together in associations like yours and after considerable discussion and with a great deal of enthusiasm are developing codes of ethics or, to use what seems to be a more satisfactory term, codes of business procedure. Unfortunately, some groups after such an effort, shake hands over the satisfactory completion of a code of business procedure and then the minute they get outside the door, forget the code and continue the same bad practices making for unfair competition and unsound business as were carried on before the development of the code.

It certainly won't help us as business men to set up a code of business practice or attempt other constructive activities unless we appreciate that in this day of unrivalled competition we must act as thinking men, as sportsmen; that we shall get together in such a way that we can make the word "cooperation" mean something in bringing about better business and sounder profits.

If we can, through our trade associations, develop that confidence that will make possible voluntary adherence on the part of the members of the organization to the accepted code of business principles, we are bound to get the kind of backing from entire industries for our associations that will make it possible for us to meet effectively these difficult problems of overproduction, price-cutting and so forth, and that in a perfectly legal way.

Meeting Difficult Economic Problems on a Legal Basis

Reference has been made to the fact that the question is being asked constantly as to whether we can meet these serious problems of overproduction, price-cutting, invasion of sales territory and wasteful and harmful practices that are making for unfair competition and unsatisfactory business in a perfectly legal way.

Recently the executive of an important trade association indicated the difficult conditions existing in his industry, saying: "We are being forced every day to meet this new competition, this competition between industries rather than individuals in an industry. We are being crowded to the wall; being bled white by the competition of other industries. And because of these difficult conditions, can we get together in an association and legally meet and solve these problems of price-cutting, invasion of territory, and so forth?"

It is more than apparent after years of satisfactory experience in association work that we can meet those problems legally; that after all the anti-trust legislation which is so often objected to has certain values in regulating the relationships of business men in this country, and that it is not so restrictive but that we can operate associations of business men in such a way as to make for sound stabilization of business.

How can we meet these serious problems legally? Through constructive work of the trade association, and only through that agency, at this time. If you and the members of other trade associations through the country will recognize the fact that you are no longer a loosely-organized and perhaps a semi-social organization, but rather that you are a closely-knit organization becoming an industry-wide corporation, and if

on the basis of real confidence in each other and in your association you will put into the hands of your association staff the intimate information as to your individual business that they must have if they are to develop an effective industry-wide business statement, then the development of such a statement for your industry as a whole should allow the individual business man to form his own judgments as to his production program, as to the price he must charge to make a profit, and as to his market, whether he shall continue to operate in a national market or whether he needs to confine himself to a local market. Experience is proving that if you will put yourselves solidly back of your organization, giving to the staff the information that they need along statistical, cost and other lines, that you should be able, through your association, to develop a business information service, a business picture that should simplify the formation of sound individual judgment as to production program, price and market.

Legal Bounds in Trade Association Work

There has been a good deal of question, and still is, on the part of business men, as to how far they can go legally in their association work. As a result of the Supreme Court Decisions of 1925, we feel that a charter has been laid down for modern trade association work, and that there is therefore little need of any trade association today not knowing fully as to just what they can and cannot do legally.

We know that we cannot get together in an association or as groups in an organization and agree as to the prices of our product or the prices at which we propose to sell as jobbers or retailers, or whatever our position in the industry may be.

We cannot get together as an association or as groups in an association, or even two of us as long as we are acting in the name of the association, and agree to restrict production.

We know that we can't get together and agree to divide territory. We know that in credit bureau work, for instance, we can't set up and distribute a black list. We know that in our statistical work there are certain things we cannot do legally.

But these things we cannot do as associations are known thoroughly by the men managing associations, or they should be known. There is little cause for fear as to danger lurking in the pathway that associations in this country must travel. As indicated in the beginning—if we will observe the rules of the road and be good sportsmen, we will find that we can go a long way in accomplishing in association work what is needed in bringing about better business, and business on a sounder profit.

Better Business Through Better Trade Relations

There is another activity which is very much before us in association work today. An activity which is a tangible service, a tangible effort of very great importance, and that is concerted action through our trade associations in the elimination of wasteful and harmful practices making for unfair competition within the meaning of the law, or practices which we know to be uneconomical and unsound from a business standpoint.

It should be of very great interest to discuss briefly what is being done in American industry in removing these unfair and unbusinesslike practices and what the effort is meaning to industry. We know that industry is carrying a heavy burden of expense as a result of practices that have grown up easily and insidiously often to the point where the industry has become the victim.

In one industry, which though not a large industry, yet, is an important one doing a gross annual business of about sixty million dollars, one unfair practice, closely allied to commercial bribery, grew up within the industry and finally reached the point where the industry had to recognize it. Therefore, the industry got together, agreed to eliminate that practice, went through a trade practice conference under the Federal Trade Commission, and relieved themselves of that practice. In doing this the industry made a careful estimate of what that one practice was costing them. Their conservative estimate was that this one practice was costing them a million dollars a year out of a gross business of sixty million.

We are now working in the National Chamber with some eighteen different industries, helping to define these bad practices, helping to bring the industries together and into agreement to eliminate them, and where necessary, helping the industries on through a trade practice conference under the Federal Trade Commission.

Once in a while as we sit in with representatives of an industry, and as we present the values that would accrue to them in getting rid of these practices, they say: "We don't have any of them." Then we refer to harmful practices that exist in other industries and they say: "Sure, we have those." We haven't yet found an industry where there are not practices that

are making either for unfair competition or for conditions that are uneconomic or unbusinesslike.

Here are a few of these bad practices that exist in different industries: price discrimination, secret rebates, misrepresentation, deceptive advertising, inducing breach of contract, misbranding, selling below cost. These practices which are often putting such burdens on industry are being eliminated from industry steadily today through trade practice conferences under the Federal Trade Commission.

It is increasingly apparent that one of the most constructive things that can be done through our trade associations today,—and it might be carried out in such a way that it would be very helpful to you—is the elimination of some or all of these wasteful and harmful practices. And certainly they don't all exist in your industry. Yet, what a fine, constructive thing it would be for your industry if you could eliminate such practices as may be harmful and may be costing your industry real money that doubtless you need to retain in your business.

Advertising and Trade Promotion

There are other constructive association activities that are exceedingly important to us. If time permitted, we could, of course, go down the line of statistics, cost accounting, standardization and simplification and so on—all activities of great importance. But just a word as to trade extension and trade promotion. We are spending a great deal of money in and through associations on advertising and we are getting some results—some very effective results in some industries. But we are learning gradually, as a result of years of experience in association advertising, that advertising is but one phase of a trade extension campaign. There are other phases, possibly as important as advertising. We must be sure that an industry is ready for an advertising campaign. We must be sure that the industry, when the campaign is put on, knows what it is all about and is in position to take full advantage of the campaign. There is need for sound research, for sound educational work, that will make an industry in which an advertising campaign is to be carried on ready for it, and fully ready to take advantage of it. And after the campaign is put on, there should be means whereby the advertising can be followed through to the ultimate consumer in the way of service and in other ways.

Developing an Industry Consciousness

There is one final result of association work that should be referred to as it is evident that you are beginning to get this particular result in your industry. You come together here and discuss your common problem. You are meeting each other. You are meeting your competitor. You are seeing that after all the American business man is fundamentally honest; that he wants to do business on a sound basis; that he doesn't want to do business in ways that make for unfair practice, or practices that are uneconomic or unbusinesslike.

And as you come together you are developing gradually an industry consciousness; you are appreciating the fact that you belong to an important industry. And your industry is growing in importance from year to year. There is a great future before you as an industry, as a business; yet, a greater future is evident if you can develop out of this association work an industry consciousness—a feeling that the executives of your companies in whatever they do within their own companies cannot confine the influences of these actions to themselves or their companies or even their groups, but that what they are doing from day to day affects the entire industry—in other words, that no one business man in this group can live unto himself alone, can so carry on his business that he will not affect others from day to day in the larger industry to which he belongs.

Developing a Program for Industry

It is not only in meeting this new competition that we must get together, but it is increasingly evident that we have got to speak as a unit, not only in legislation and in contact with the public but in all of those other tangible activities which have been described.

An important result from aggressive tangible service carried on through the association should be the development of a program not only for your business but for your industry as a whole. Doubtless your individual business is carefully programmed. You have set up a budget and you know about what your business is going to be in the year ahead. But have you thought of a program for the industry as a whole? Where is your industry headed? Have you as an industry, anything to say about new plants coming into the business? Are you as an association influencing in any way the trend of development in the industry of which you are a part?

The paper industry, like other industries, through the years has grown like Topay,—without exercising conscious direction as to its own future growth. It would seem to be standing helplessly by and letting development come from the outside apparently as the re-

sult of pressure for the investment of idle funds. Industry generally seems to be suffering because it has not exercised conscious direction as to its future growth. And an industry can exercise conscious direction as to its future growth in a perfectly normal and legal way.

If you are not building a program for the future development of your business and your industry, it is time that you give it consideration, particularly as the only way that you can develop an effective industry program is through your trade association. Coming together here in this convention and developing sound ideas as to effective business cooperation should make it easy to take the next step and evolve a program that should let you direct, to a considerable extent, the future development of your business, and that on a perfectly legal basis.

The Trade Association Department of the National Chamber

In closing, let me describe briefly the new Trade Association Department in the National Chamber and what we are hoping to do, with your help, in furthering the sound up-building of trade association work in this country.

There are three main objectives in the work of this new Department.

First; through aggressive educational and promotional work we want to evaluate or sell the trade association idea to (a) members of trade associaitons, working always through the officers of the association. We haven't yet found a trade association, whether it is five years or fifty years old, where seventy-five per cent of the members are completely sold on the association. There is a real piece of work to be done in building up sound associations in business; associations that will make for better business and sounder profits, if we can carry on, with your help, the kind of educational and promotional work that will effectually sell the trade association to members of trade associations.

And (b) to the public. What does the public think, if it thinks at all, about your getting together here in this convention? That is, the public not concerned directly with business. You know that the public is more than likely to conclude you are gathered in this meeting to evade the law or to fix prices. That may sound a bit exaggerated but you try the experiment of asking the man on the street what he knows about trade associations and you will doubtless find the opinion expressed above. We want to take to the public the constructive work that you and many other associations are doing. We want to convince the public that the well managed trade association of today is in existence to bring about better business and to serve the public. Time will not permit a description of the very constructive things trade associations are doing for the public through research, through better merchandising, and in other ways.

And (c) we want to evaluate or sell the trade association to the government departments with which business has contact. Administrations may come and go, but the government departments seem destined to go on forever, and we should be sure that as each year passes there is better understanding of what trade associations properly organized and managed may mean to American business.

The second objective of the Trade Association Department is to extend into trade associations the constructive work of the service departments of the Chamber.

The American Paper and Pulp Association was a charter member of the Chamber of Commerce of the United States. During my eight years with that Association we did not make full use of the Chamber because we didn't know the Chamber. Since going with the Chamber it has been my pleasure to dig quite thoroughly into the work of the Chamber's service departments. You know of the work of certain of these departments—Manufacture, Finance, Foreign Trade, Transportation, etc.

We want to project the work of these departments into the trade associations of the country. As a result of being on both sides of the fence, formerly in association work and now in the Chamber, it is increasingly evident to me that there isn't a problem coming up in trade association work where the National Chamber cannot be of assistance.

Finally, for the third objective, we want to assist unorganized industry in the formation of sound trade associations.

In carrying out this objective we are very careful not to superimpose organization upon industry, because we feel very strongly that the urge to organize should come from within a group. After the urge to organize develops we are ready to get into the picture and help to build up a strong trade association.

There are other activities and services of a more direct character included in the plan of work of this new department: such as, bringing about better business through better trade relations, by assisting industries

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The Crushed Stone Journal

Official Monthly Publication of the
NATIONAL CRUSHED STONE ASSOCIATION
Merchandise Building 1735 Fourteenth St., N. W.
WASHINGTON, D. C.

J. R. BOYD, Editor

Accident Prevention a Major Activity

IN his last address to the Association before retiring as its President, Otho M. Graves, at our Cleveland Convention last January, made three definite and specific recommendations regarding future objectives towards which he believed the Association should earnestly and seriously direct its attention. One of these recommendations had to do with the subject of accident prevention.

Many of you had the pleasure personally of hearing Mr. Graves' address and probably all of you had occasion to read it in the last issue of the Journal, but for the purpose of emphasis we believe that his comments on this subject bear repeating and we are therefore quoting from his Cleveland address as follows:

> "A third and concluding major activity for the Association which I wish to suggest at this time is that of accident prevention. * * *
>
> "Yet but slowly have we come to the realization which now seems to be crystalizing into effective action, that fundamental as is the conservation of our natural resources, even more basically important is the protection of the worker. This is neither the time nor the place, nor is it at all necessary to indicate to you that of which you are already aware—that the prevention of industrial accidents is not only a humanitarian expression of practical Christianity, but also results in increased production and greater profit. These things are known to you and I briefly refer to them only for the purpose of urging that our Association should more actively engage itself in assisting its members to reduce measurably and materially their accident rates. Nor shall I endeavor to indicate the means and methods whereby the Association can discharge this important duty which I believe rests upon it. The essential thing is that we recognize the obligation, and out of that recognition will grow the method for its fulfillment. The employee is not in a position to ask that he be protected; he would feel that it was undignified and cowardly to do so. But the responsibility for his reasonable protection rests on the executive, none the less, and I hold that this Association would be derelict in its duty if it did not stimulate and assist the executives of our member companies in discharging this high obligation."

The newly elected Board of Directors of the Association at its meeting held immediately after the conclusion of the Cleveland Convention took action on this question as follows:

> "It was moved by Mr. Graves, seconded by Mr. Krause and carried that the President appoint a committee on Accident Prevention for the purpose of investigating ways and means whereby the Association can materially assist its member companies in reducing industrial accidents at their plants."

From the foregoing it is clearly evident that it is the desire and intent of the Association to include accident prevention as one of its major activities.

In accordance with the action of the Board of Directors, President Wise, immediately following the convention, appointed a Committee on Accident Prevention, with Mr. H. E. Rodes of the Franklin Limestone Company of Nashville, Tennessee, as Chairman. Mr. Rodes has earnestly undertaken the work of his Committee and we are assured, under his able chairman-

ENTRY APPLICATION

Director, Bureau of Mines,
Department of Commerce,
Washington, D. C.

SUBJECT: National Safety Competition, 1929.

DEAR SIR:

This company desires to enter the National Safety Competition for 1929. A complete record of each lost-time accident in the calendar year 1929 disabling an employee longer than the remainder of the day of accident will be forwarded to your office. Each report will show the number of calendar days of disability of the injured employee and date of employee's return to duty. At the close of each month the number of employees and time worked will be reported. The identity of the property for which accident reports will be furnished is indicated below.

The number of men regularly employed underground is approximately _____

The number of men regularly employed in the quarry pit is approximately _____

The number of men regularly employed in the open-pit mine is approximately _____

Very truly yours,

_____Company

_____Signature

_____Title

Name of underground mine _____

Name of quarry or open-pit mine _____

Location: State _____County _____P. O. _____

Kind of mineral or stone produced _____

(Note—Carbon copies of regular forms prescribed by Compensation Commission of your State may be used in furnishing the accident data required for the contest; or, if you desire, the Bureau will furnish suitable forms. All "lost-time" accidents should be reported. The contest does not cover mills or smelters; and the quarry group covers only the quarry and crushing and screening plants when the latter are at the quarry. Director, Bureau of Mines).

PLEASE USE SEPARATE APPLICATION BLANK FOR EACH MINE OR QUARRY WHICH YOU DESIRE TO ENROLL IN THE CONTEST. ADDITIONAL BLANKS WILL BE FURNISHED UPON REQUEST.

ship, that real and definite progress in accident prevention will be made during the present year. Plans for the work of the Committee are now being formulated and you will undoubtedly hear direct from Chairman Rodes in the near future.

In the meantime there is one way in which every member of the Association can render valuable assistance in furthering the reduction of accidents throughout the crushed stone industry. To intelligently and effectively promote accident prevention comprehensive accident statistics are vitally necessary. Such data is particularly helpful in definitely ascertaining the problems involved and in suggesting solutions which can be applied to them. Safety contests have proven to be one of the most effective means for obtaining such statistical information and at the same time stimulating interest in the reduction of accidents.

We earnestly suggest that if you have not already done so you immediately enter the National Crushed Stone Association Safety Contest. All members of the Association, regardless of size, are eligible to enter this contest, the only requirement being that the company agrees to provide the Bureau of Mines with a copy of each accident report covering lost time accidents. A carbon copy of the report which the State law already requires a company to send to the industrial accident commission is entirely satisfactory, or in the case of self-insurers copies of the reports which companies make to their insurance departments. Those companies entering the N. C. S. A. Safety Competition who are also eligible to enter the National Safety Competition (minimum requirements twenty-five men inside quarry) will automatically be entered, and also those of our members entering the National Safety Competition will be automatically entered in the N. C. S. A. Contest. An application blank is enclosed in this issue of The Crushed Stone Journal and additional ones may be obtained upon request.

The Business Man and His Trade Association

(*Continued from page* 21)

to eliminate wasteful and harmful practices; by aiding associations in the technique of organization work, etc.

We believe in carrying out the work outlined for the new Trade Association Department of the Chamber, particularly if we may count upon your help and the help of the many other associations serving American industry, that we will be living up to the opportunities and obligations which we are all facing as business men in the building up of sounder trade associations, the kind of associations that will make for better business and for sounder profits.

Business Speaks Through the Association

And out of all this organized effort in business there is bound to come a clearer understanding of our economic problems, an understanding that should make it easier for American business to speak for itself. And it is time that business men, through their trade association, should speak for themselves at Washington and elsewhere. And in speaking for themselves, business men are giving increasing evidence that they have put their business on a higher plane; that they are cleaning their own houses; and that in such a way that business is today serving the public more effectively than ever before.

From progress which you have already made in your organized effort, the years just ahead of your Association should see rapid developments of a character that should make it possible for you to pool your intelligence, your energy, and your money so as to realize more and more the goal of better business and business on a sounder profit.

You have a great opportunity before you in your Association work. You have a growing industry, and you can make it a more profitable industry; you can put your industry on a sounder basis of satisfactory business as you make cooperation really effective through organized effort.

Associate Members of the National Crushed Stone Association

Air Reduction Sales Co., 342 Madison Ave., New York City.
Liquid Oxygen Explosive.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Crushing Plants and Machinery.

American Manganese Steel Co., Chicago Heights, Ill.
"Amsco" Manganese Steel Castings.

American Tar Products Co., Union Trust Bldg., Pittsburgh, Pa.
Tar Products for Road Construction and Maintenance.

Armstrong Manufacturing Co., Waterloo, Iowa.
Blast Hole Drills, Bit Dressing Machines.

Atlas Powder Co., Wilmington, Del.
Explosives and Blasting Accessories.

Earle C. Bacon, Inc., 26 Cortlandt St., New York City.
Complete Plants, Crushers, Elevators, Screens, Conveyors.

The Barrett Company, 40 Rector St., New York City.
Tarvia for Road Construction, Repair and Maintenance.

Blaw-Knox Co., P. O. Box 915, Pittsburgh, Pa.
Manufacturers of Steel Products.

The Browning Crane Co., 16226 Waterloo Rd. N. E., Clev., O.
Locomotive Cranes.

C. G. Buchanan Co., Inc., 90 West St., New York City.
Crushers, Crushing Rolls, Magnetic Separators.

Bucyrus-Erie Company, South Milwaukee, Wis.
Shovels—Steam, Diesel, Electric and Gasoline—and Dredges.

Buffalo Wire Works, 521 Terrace, Buffalo, N. Y.
Wire Cloth and Screens.

Burrell Eng. & Constr. Co., 513 W. Jackson Blvd., Chicago, Ill.
Design and Construction.

Canadian Explosives, Ltd., Canada Cement Bldg., Mont'l, Can.
Explosives and Blasting Supplies.

Cement Mill and Quarry, 521 Fifth Ave., New York City.
"Publishers."

Chicago Pneumatic Tool Co., 6 E. 44th St., New York City.
Rock Drills, Air Compressors, Diesel Engines, Pneumatic Tools

Consolidated Products Co., 15 Park Row, New York City.
Rebuilt Equipment and Machinery.

Cross Engineering Works, Carbondale, Pa.
Perforated Metals.

The Dorr Company, 247 Park Ave., New York City.
The Dorr Washer.

E. I. du Pont de Nemours & Co., Wilmington, Del.
"Explosives of All Kinds and Blasting Accessories."

Easton Car and Construction Co., Easton, Pa.
Quarry Cars.

Ensign-Bickford Co., Simsbury, Conn.
Safety Fuse and Cordeau Bickford Detonating Fuse.

Fate-Root-Heath Co., Plymouth, Ohio.
"Plymouth" Gasoline Locomotives.

Flexible Steel Lacing Co., 4607 Lexington St., Chicago, Ill.
Alligator and Flexco H. D. Belt Fasteners.

Frog, Switch & Mfg. Co., Carlisle, Pa.
Manganese Steel Castings.

General Electric Co., Schenectady, N. Y.
Electrical Apparatus and Supplies.

Gill Rock Drill Co., Lebanon, Pa.
Blast Hole Drilling and Fishing Tools.

Good Roads Machinery Co., Kennett Square, Pa.
Crushers, Elevators, Elevator Feeders and Revolving Screens

The Goodyear Tire and Rubber Co., Inc., Akron, Ohio.
Belting: Transmission, Conveyor, Elevator; Hose Packing.

Goroco Mechanical Spreader Co., Upper Darby P. O., Phila., Pa.
Mechanical Spreader for Loose Aggregate Sand to 1-¼ sizes.

Graham Coal Company, Commercial Trust Bldg., Phila., Pa.
Coal and Coke.

Gruendler Patent Crusher & Pulv. Co., 1st & Frk., St. Louis, Mo.
Crushing, Pulverizing, Screening and Conveying Machinery.

Harnishchfeger Corp., 38th & National Aves., Milwaukee, Wis.
Gasoline, Electric and Diesel Shovels—Cranes, Draglines.

The Hayward Co., 50 Church St., New York City.
Hayward Orange Peel and Clam Shell Buckets.

Heisler Locomotive Works, Erie, Pennsylvania.
Geared Locomotives.

The Hendrick Mfg. Co., Carbondale, Pa.
Perforated Metal Screens, Elevator Buckets.

Hercules Powder Co., Wilmington, Del.
Explosives and Blasting Supplies.

C. W. Hunt Co., 1580 Richm'd Terrace, W. New Brighton, N. Y.
Mitchell Electric Vibrating Screen.

Illinois Powder Manufacturing Co., St. Louis, Mo.
Explosives and Blasting Supplies.

Ingersoll-Rand Company, 11 Broadway, New York City.
Rock Drills, Steel Sharpeners, Oil Furnaces and Hoists.

The Jeffrey Mfg. Co., Columbus, Ohio.
Elevating and Conveying Machinery.

Keith Dunham Co., 110 S. Dearborn St., Chicago, Ill.
L. O. X. (Liquid Oxygen Explosive) Loxite Cartridges.

Kennedy-Van Saun Mfg. & Engr. Corp., 50 Church St., N. Y. C.
Kennedy Gyratory Crushers.

Kensington Steel Co., 505 Kensington Ave., Chicago, Ill.
Manganese Steel and Alloy Steel Castings.

Keystone Lubricating Co., Philadelphia, Pa.
Lubricating Greases and Lubricating Devices.

Koehring Company, Milwaukee, Wis.
Gasoline Shovels, Cranes and Draglines.

Koppel Industrial Car and Equipment Co., Koppel, Pa.
Quarry Cars in hand & air operated designs—Track Material.

Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill.
Elevating, Conveying, Screening and Power Trans. Mach.

The Loomis Machine Co., Tiffin, Ohio.
Blast Hole, Prospecting and Drilling Machinery and Tools.

Manganese Steel Forge Co., Richm'd St. & Erie Ave., Phila., Pa.
"Rol-Man" Screens, Chains, Plates and Forged Products.

The Marion Steam Shovel Co., Marion, Ohio.
Power Shovels and Cranes—Steam, Gasoline and Electric.

National Malleable & Steel Cast. Co., 10600 Quincy Ave., Clev, O.
Naco Cast Steel Steam Shovel Chain & Certified Mall'ble Cast.

Niagara Concrete Mixer Co., 40 Pearl Street, Buffalo, N. Y.
"The Niagara Screen."

Nordberg Manufacturing Co., Milwaukee, Wisconsin.
Ore, Rock and Gravel Crushers.

The Osgood Company, Marion, Ohio.
Power Shovels and Combinations.

Peerless Explosives Co., 22 N. Franklin St., Wilkes-Barre, Pa.
Explosives and Blasting Supplies.

Pit and Quarry, Rand McNally Bldg., Chicago, Ill.
"Publishers."

Pittsburgh Coal Washer Co., Ambridge, Pa.
Vibrating Screens.

The H. K. Porter Co., 49th & Harrison Sts., Pittsburgh, Pa
Locomotive Builders.

Productive Equipment Corp., Builders' Bldg., Chicago, Ill.
Manufacturers of The Jigger Circle-Throw Vibrating Screen.

Robins Conveying Belt Co., 15 Park Row, New York City.
Material Handling and Screening Equipment.

Rock Products. 542 So. Dearborn St., Chicago, Ill.
"Publishers."

The Sanderson-Cyclone Drill Co., Orrville, Ohio.
Drills, Big Blast Hole, Drilling and Fishing Tools.

Sauerman Bros., Inc., 438 S. Clinton St., Chicago, Ill.
Cableway Excavators, Power Scrapers.

Simplicity Engineering Co., Durand, Michigan.
Vibrating Screens.

The Orville Simpson Co., 1230 Knowlton St., Cincinnati, O.
Screens, ROTEX, level, self-cleaning, 100 to ¾" mesh.

The Stearns Conveyor Co., 200th St. & St. Clair Ave., Clev., O.
Material Handling Machinery.

Stephens-Adamson Manufacturing Co., Aurora, Ill.
Speed Reducers and Belt Conveyor Carriers.

Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
TISCO Manganese Steel Castings.

The Thew Shovel Co., Lorain, Ohio.
Steam, Gasoline and Electric Shovels, Cranes, Draglines.

The Traylor Engineering & Mfg. Co., Allentown, Pa.
Crushing, Cement and Mining Machinery.

Traylor Vibrator Co., 1400 Delgany St., Denver, Colorado.
Vibrating "Screen Supreme."

Troco Lubricating Co., Philadelphia, Pa.
Manufacturers of Petroleum Products.

Trojan Powder Co., Allentown, Pa.
Explosives and Blasting Supplies.

The W. S. Tyler Co., Cleveland, Ohio.
Woven Wire Screens and Screening Equipment.

Union Explosives Co., Clarksburg, W. Va.
Explosives and Blasting Supplies.

Vulcan Iron Works, Wilkes-Barre, Pa.
Steam, Gasoline, Electric Locomotives.

Western Wheeled Scraper Co., Aurora, Ill.
Western Portable Rock Crushers.

George D. Whitcomb Co., Rochelle, Ill.
Gasoline Locomotives.

Williams Patent Crusher and Pulverizer Co., St. Louis, Mo.
Hammer Crushers.

Woodhouse Chain Works, Trenton, New Jersey.
Welded Link Chains—Steam Shovel.